[0017] The embodiment(s) of the present invention discloses a haptic system capable of generating a sequence of haptic cues in accordance with one or more predefined events. In one embodiment, the haptic system includes a haptic device and multiple sensors, wherein sensors and haptic actuators may be constructed in a same component. After sensing one or more events, the sensor generates an input in response to the sensed event or events and subsequently forwards the input to the haptic device. Upon receipt of the input from the sensor via a wireless network, the haptic device retrieves a haptic signal from a tactile library in accordance with the input. A haptic feedback or a sequence of haptic cues in accordance with the haptic signal is subsequently generated.

[0018] FIG. **1** is a diagram **100** illustrating a runner wearing a haptic pacing system in accordance with one embodiment of the present invention. Haptic pacing system or haptic device **102** is configured to attach to the runner's arm and generates a sequence of haptic cues to pace with runner's strides. It should be noted that haptic pacing system **102** can be located anywhere on the runner's body. System **102** may include multiple sensors for detecting events. In an alternative embodiment, haptic pacing system **102** includes a separate sensing unit **106**, which attaches runner's ankle sensing and collecting various runner physical condition(s), such as runner's heart rate, speed, and blood pressures. Haptic pacing system **102**, in one embodiment, can be calibrated and/or configured to accommodate runner's characteristics and/or physical capabilities for optimizing runner's performance. An advantage of using the tactile pacing feedback cues is to improve athletic training efforts and performance.

[0019] A series of haptic cues, a sequence of haptic pacing sensations, or haptic feedback is generated by haptic pacing system **102** to assist or pace user's running steps. A purpose of the embodiment(s) of the invention is to enhance user's running performance in response to certain detected events. For example, a runner should improve his or her athletic performance by following a series of haptic cues. A series of haptic cues provide a range of optimal running pace for the user under the current detected physical condition(s). It should be noted that the underlying concept of the embodiment of the present invention would not change if additional devices such as sensors were added to diagram **100**.

[0020] System **102** includes a sensor and an actuator, wherein the sensor and actuator may be constructed in the same device. Alternatively, system **102** includes multiple sensors and multiple haptic actuators. Sensors are used to detect conditions of the runner while actuators are used to provide haptic cues in accordance with the conditions. For example, a heart rate sensor is capable of sensing runner's heart rate while a temperature sensor measures the runner's body temperature. Detected information such as heart rate and body temperature are subsequently processed, and a series of haptic cues are generated indicating the optimal runner's pace under the currently detected information. It should be noted that the terms haptic cues, tactile cues, sequence of vibrotactile cues, and tactile cues can be used interchangeably. Also, haptic feedback can be referred to as tactile effect, tactile feedback, haptic effect, force feedback, or vibrotactile feedback.

[0021] Referring back to FIG. **1**, a sensing unit **106** with multiple sensors is attached to the runner, wherein the unit **106** is logically connected to system **102** via a wireless communications network. Unit **106** may be used to detect the runner's heart rate, body temperature, ambient condition, other runners' conditions, and the like. It should be noted that system **102** may be configured to manage multiple separate sensing units **106** wherein sensors in sensing units **106** can be separately attached to the runner. A function of haptic system **102** is to provide optimal pacing mechanism to improve a runner's performance under the runner's physical as well as ambient conditions. The ambient conditions include up-hill, down-hill, weather condition, and the like. It should be noted that the feedback mechanism could be located anywhere on the body, such as in the shoe(s), on the wrist, in a helmet, etc.

[0022] The wireless communications network may include local radio frequencies, Bluetooth, cellular (GPRS, CDMA, GSM, CDPD, 2.5G, 3G, etc.), Ultra-WideBand (UWB), WiMax, ZigBee, and/or other ad-hoc/mesh wireless network technologies. To reduce power consumption, system **100** may use a relay station to amplify signal strength to conserve the power. For example, a relay station can receive haptic signals from other haptic device worn by other runners to conserve power and coverage.

[0023] System **102** can also be used in team sports such as swimmers in water polo or cyclists on a tour to identify the condition of each athlete on a team. For example, system **102** may inform one of the cyclists to speed up or slow down to improve team performance. Alternatively, system **102** can also be used to improve synchronization between athletes. It should be noted that system **102** can also be used for other applications such as assembly lines in a factory or patients in a hospital.

[0024] FIG. **2** is a diagram **200** illustrating a person **204** wearing a haptic device **202** in accordance with one embodiment of the present invention. Haptic device **202**, in one embodiment, is used by person **204** to monitor his or her physiological conditions. For example, person **204** wants to exercise but he or she needs to monitor the exertion rate. Haptic device **202**, for instance, has sensors monitoring user's heart rate when he or she is exercising or walking. In addition, haptic device **202** may also measure user's body temperature on a continuous base or in a fixed time period and warn the user if his/her body temperature is in an abnormal zone. Haptic device **202** generates a haptic warning signal to warn user **204** if his or her physiological condition reaches an abnormal level. In one embodiment, haptic device **202** is capable of generating different haptic warning cues for different physical abnormalities. For example, haptic device **202** generates two different haptic cues to inform the user that his or her body temperature is normal while his or her heart rate is a little high. It should be noted that the level of abnormality can be set by a user.

[0025] Haptic device **202**, in one embodiment, includes multiple sensors, wherein some sensors may be located within haptic device **202** while some sensors are separate units, which can be placed or attached to multiple locations over the body of a user. For example, a heart sensor may be placed or attached to a place closer to the heart in order to accurately detect heart conditions. Upon detecting the physical data such as heart and temperature readings, haptic device **202**, for example, computes an exertion rate in response to the detected data and compares the exertion rate with a range of predefined normal exertion rates. If the exertion rate reaches to an abnormal rate, haptic device **202** generates tactile feedback to warn the user about his or her condition. Upon noticing the warning tactile feedback, user should slow down or stop doing what he or she was doing to avoid additional